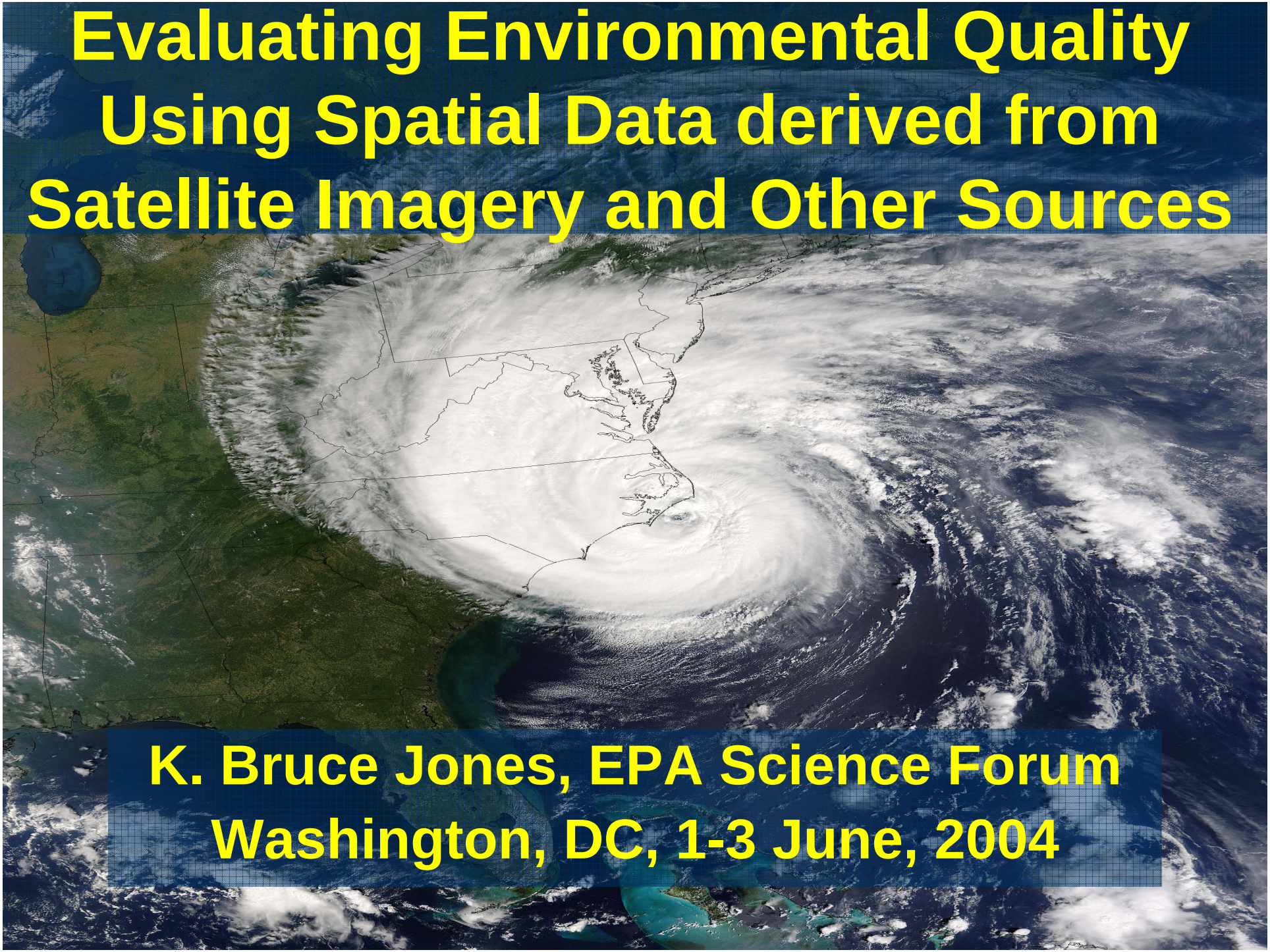
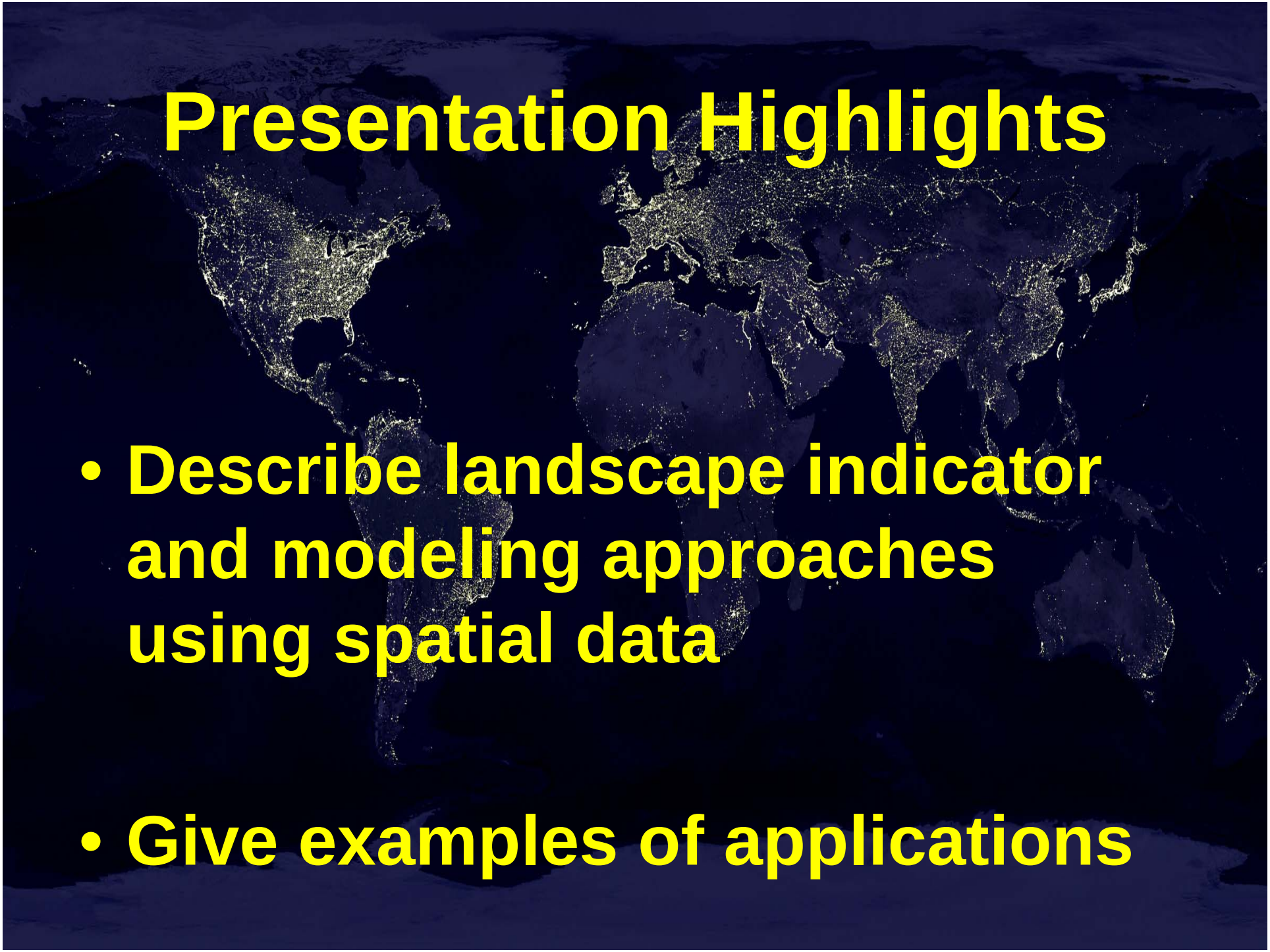
Evaluating Environmental Quality Using Spatial Data derived from Satellite Imagery and Other Sources



K. Bruce Jones, EPA Science Forum

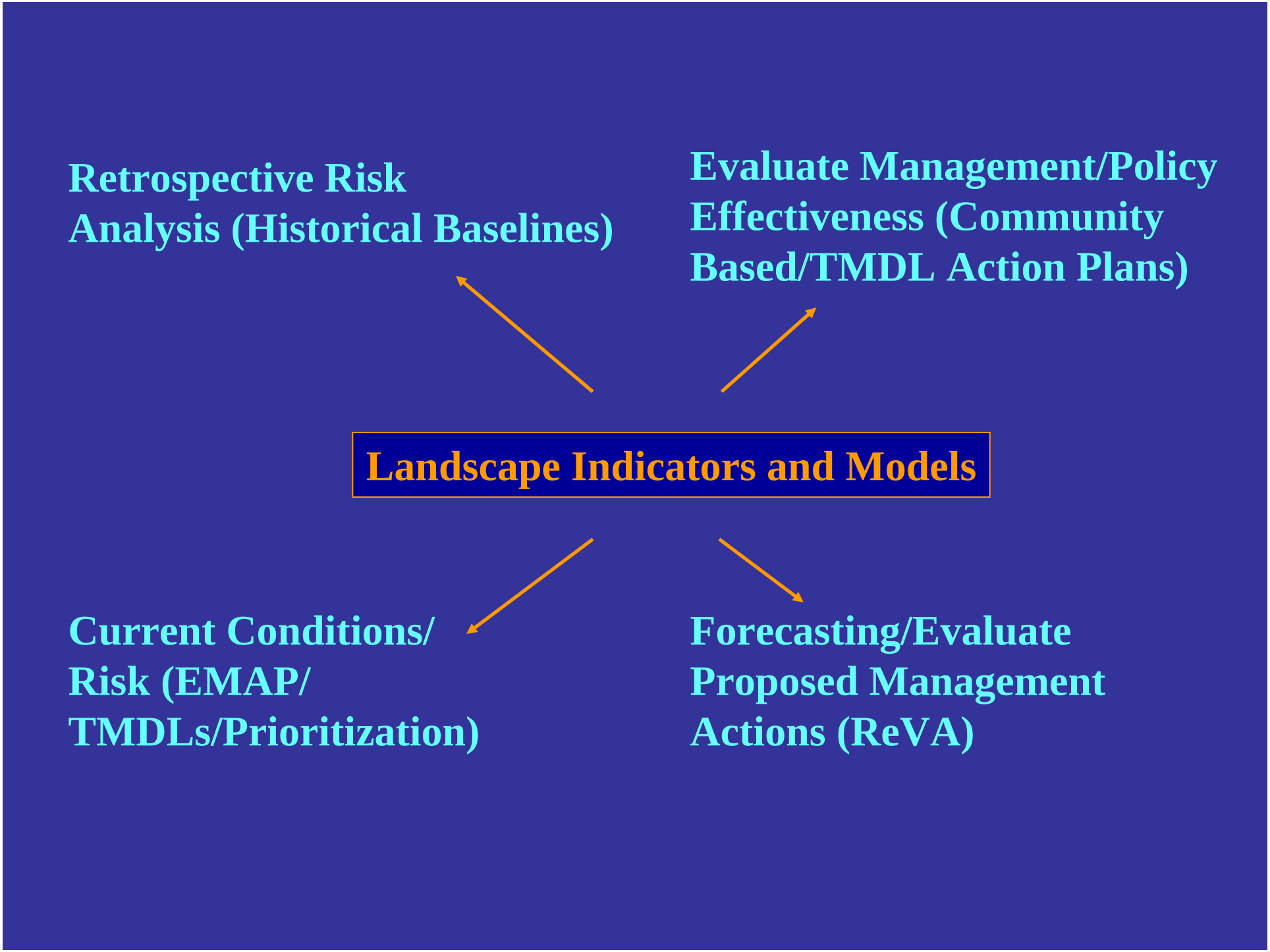
Washington, DC, 1-3 June, 2004



Presentation Highlights

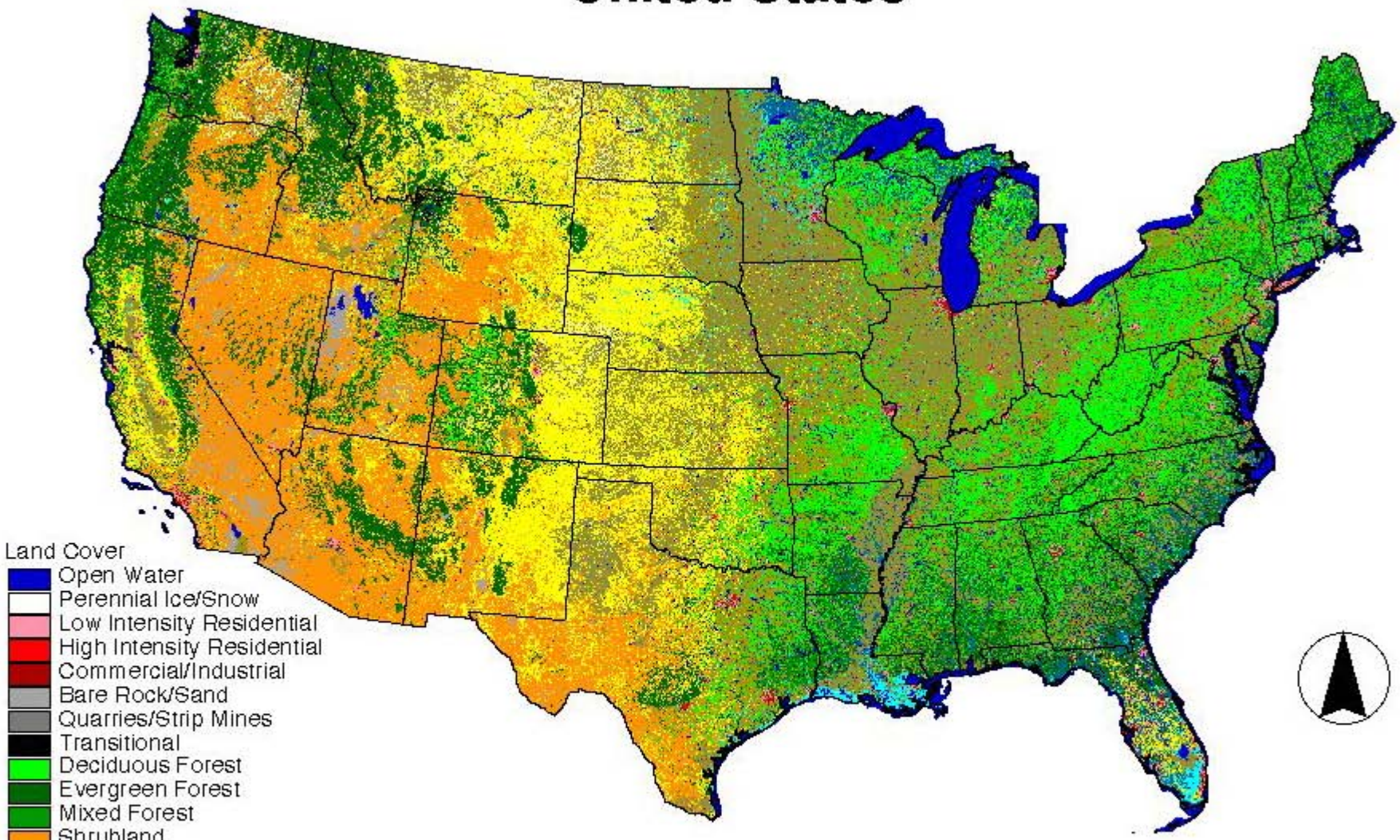
- Describe landscape indicator and modeling approaches using spatial data

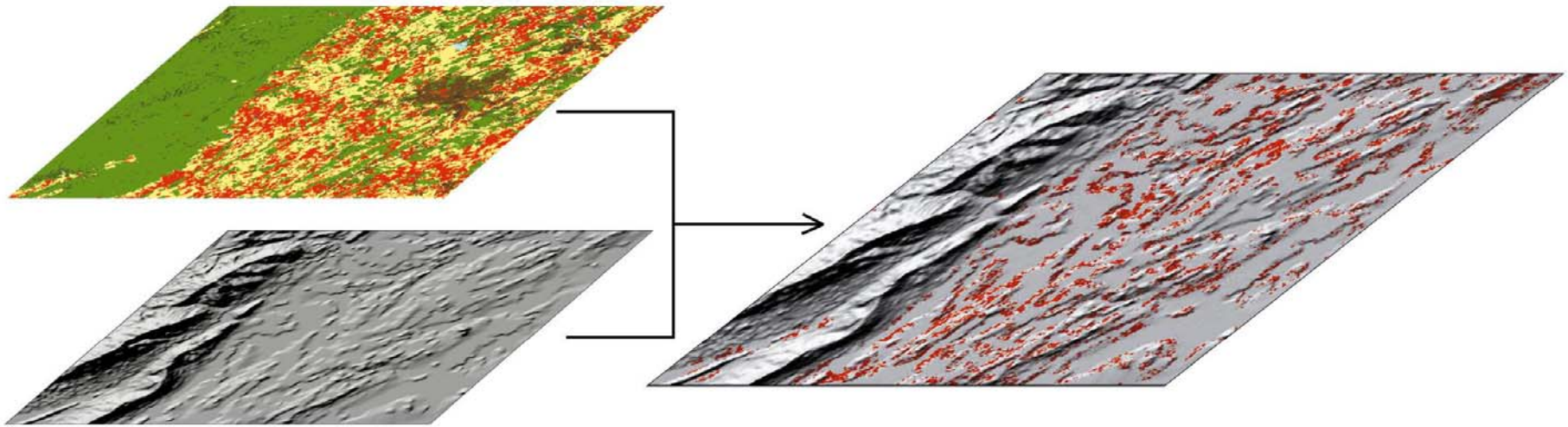
- Give examples of applications


Retrospective Risk Analysis (Historical Baselines)
Evaluate Management/Policy Effectiveness (Community Based/TMDL Action Plans)
Landscape Indicators and Models
Current Conditions/ Risk (EMAP/ TMDLs/Prioritization)
Forecasting/Evaluate Proposed Management Actions (ReVA)

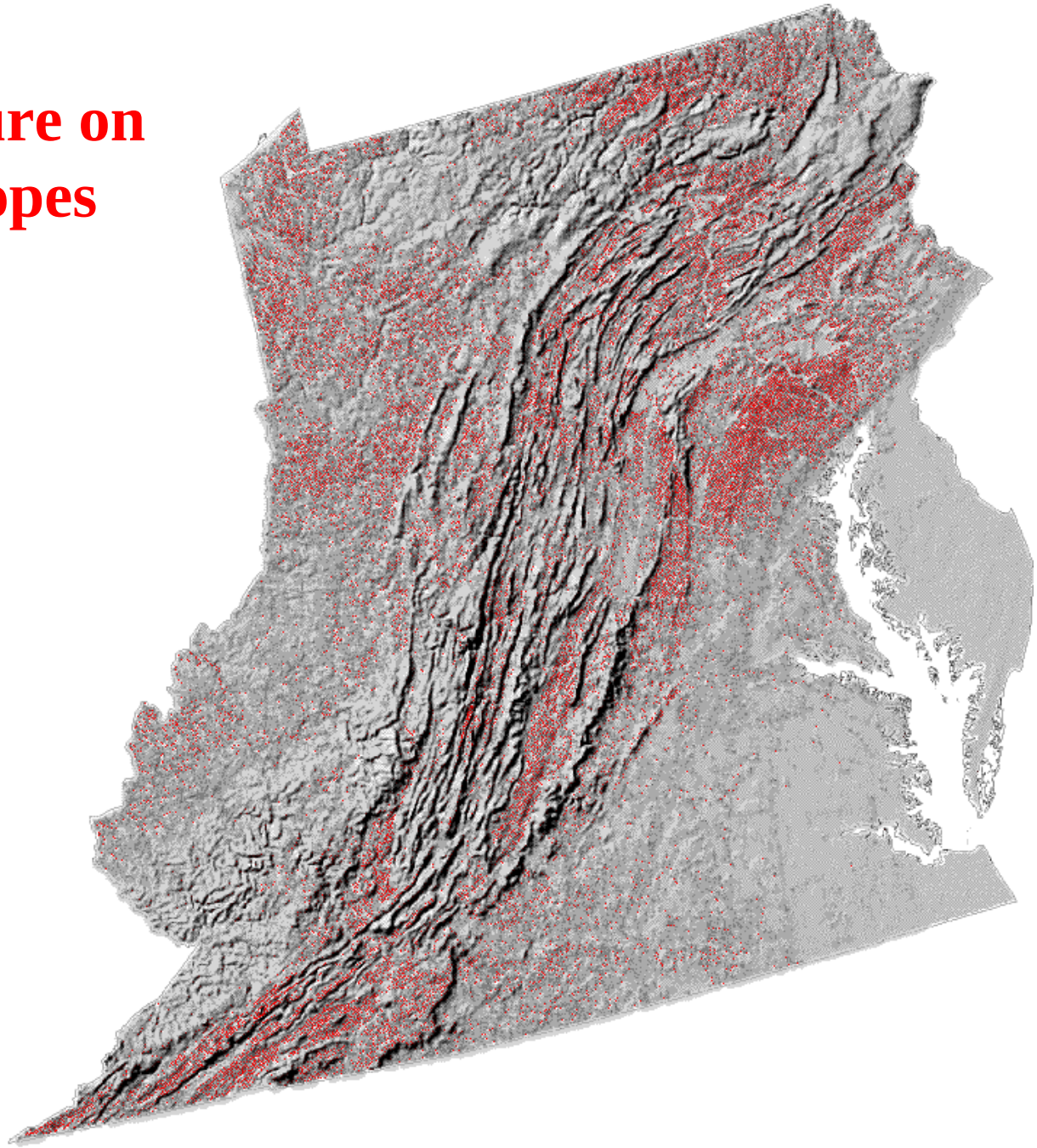

Indicators and Landscape Models

MRLC Land Cover of the Conterminous United States





Agriculture on > 3 % Slopes



Landscape Metrics

Mean Riparian agriculture
Riparian forest
Forest fragmentation
Road density
Forest land cover
Agricultural land cover
Agricultural land cover
on steep slopes
Nitrate deposition
Potential soil loss
Roads near streams

Slope gradient
Slope gradient range
Slope gradient varianc
Urban land cover
Wetland land cover
Barren land cover

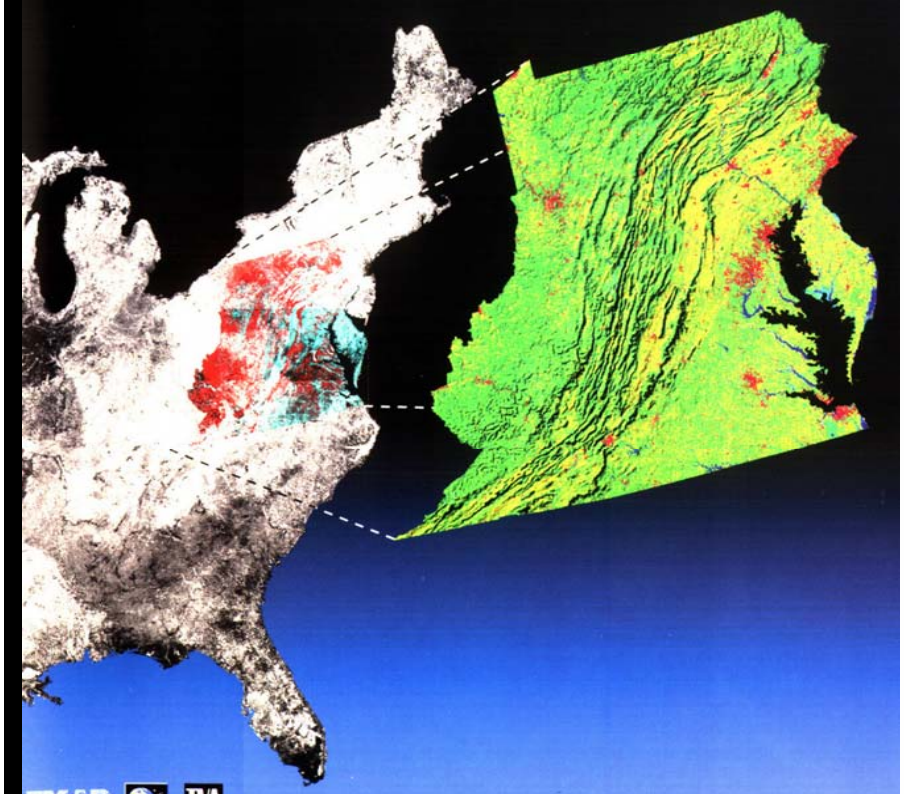
United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-97/130
November 1997

EPA

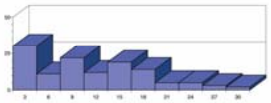
An Ecological Assessment of the United States Mid-Atlantic Region

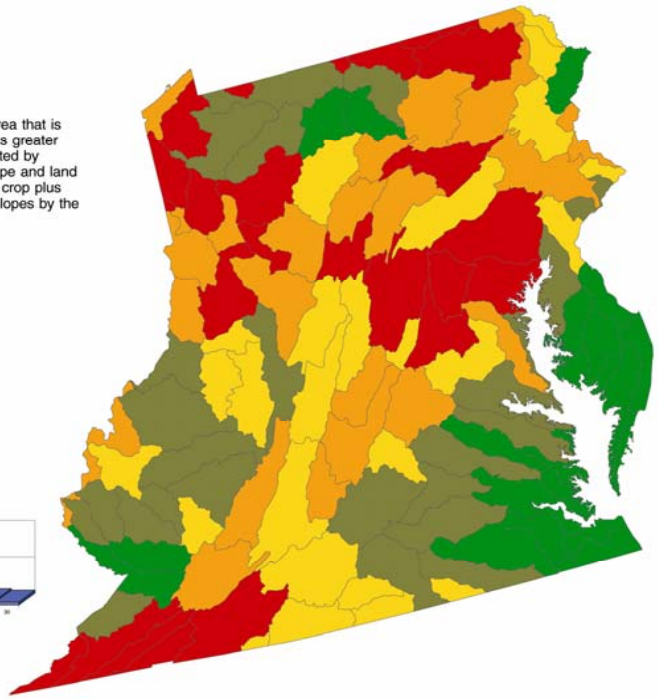


EMAP TVA

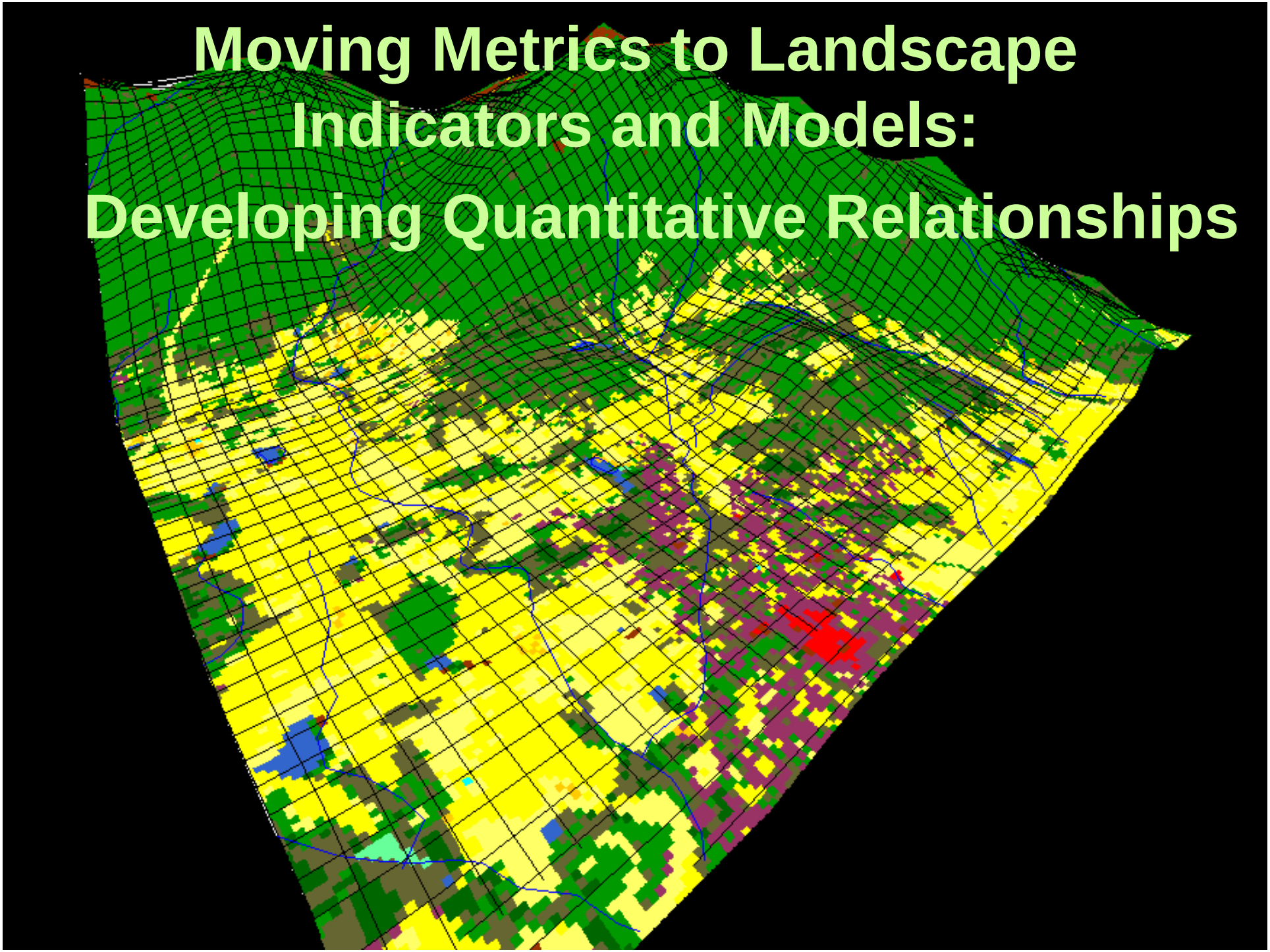
The proportion of watershed area that is agriculture land cover on slopes greater than three percent was calculated by overlaying maps of percent slope and land cover, and dividing the area of crop plus pasture land covers on steep slopes by the total area of the watershed.

Quintile	Data Range (Percent)
1	< 2.4
2	2.4 - 6.7
3	6.7 - 11.4
4	11.4 - 15.6
5	>15.6





Moving Metrics to Landscape Indicators and Models: Developing Quantitative Relationships

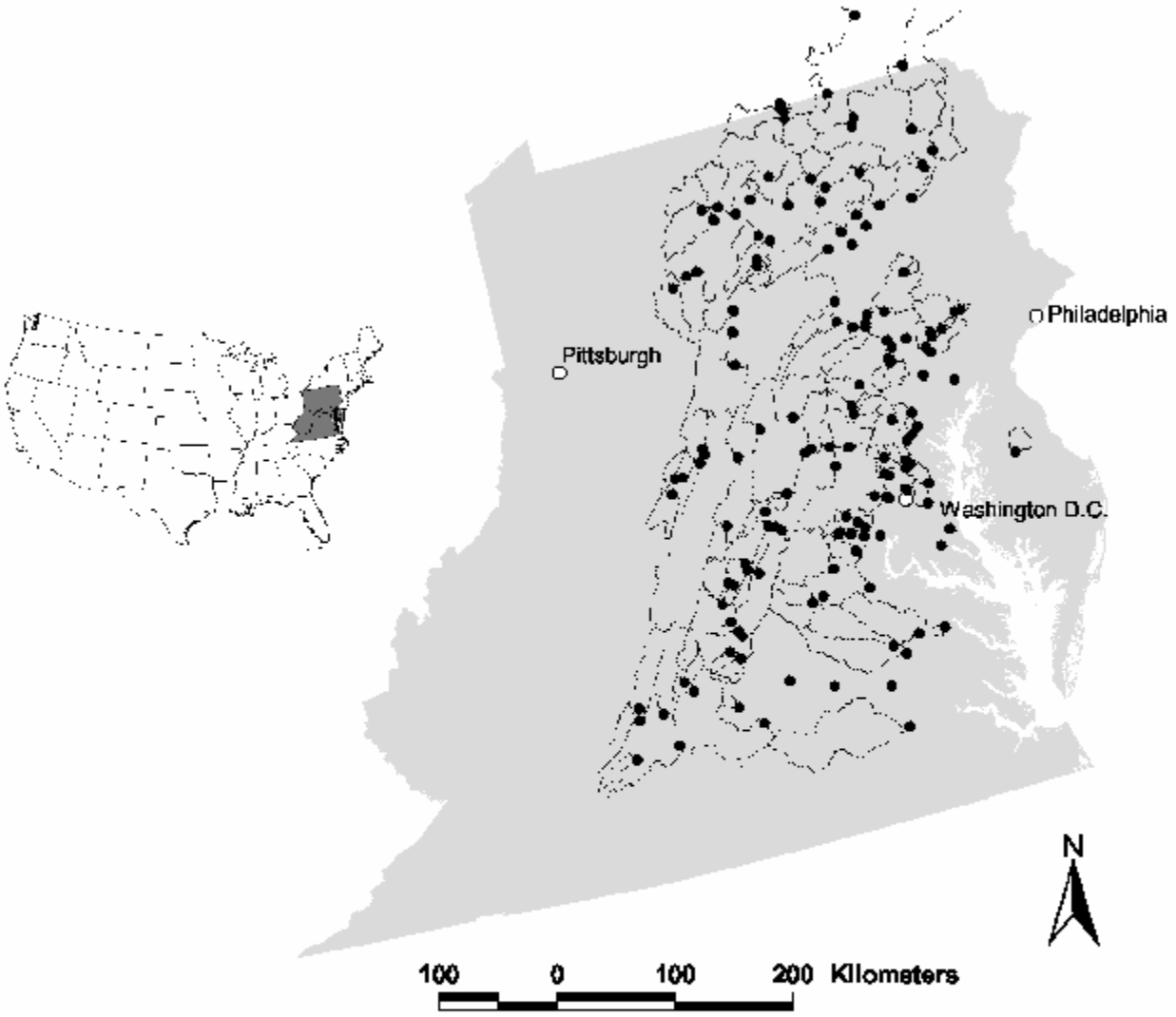


General Types of Approaches to Quantify Relationships

- Empirical
  - Multivariate
- Bayesian
- Process-based models
- Data mining/inductive

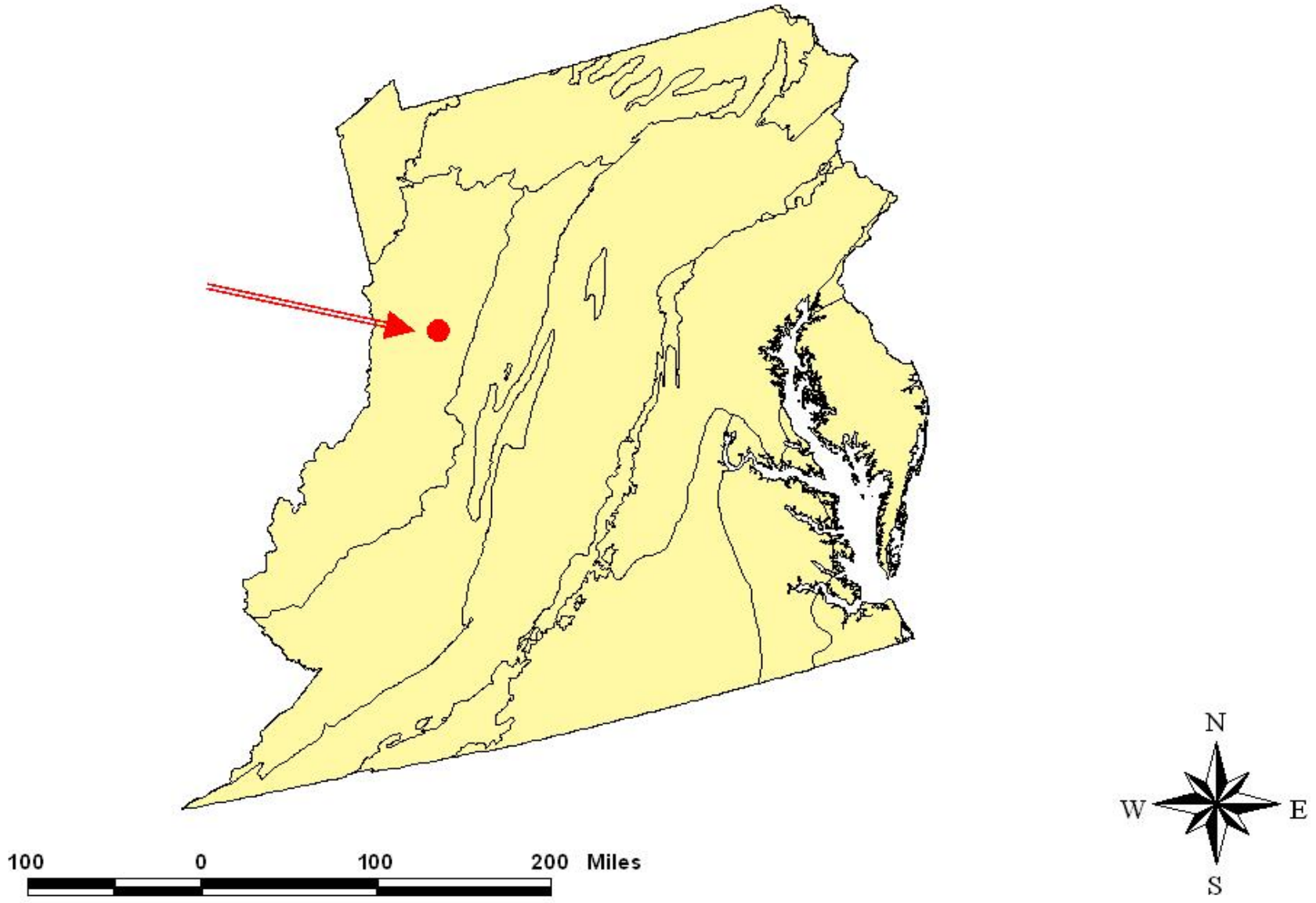
General Approach

- Select specific endpoint of interest (e.g., TMDL parameter)
- Collect/acquire field samples
- Filter data based on selection criteria
- Assemble spatial data at various scales on various units (functional and arbitrary)
- Generate metrics and/or measures … pair metrics with individual samples sites in a SAS database
- Conduct statistical analyses

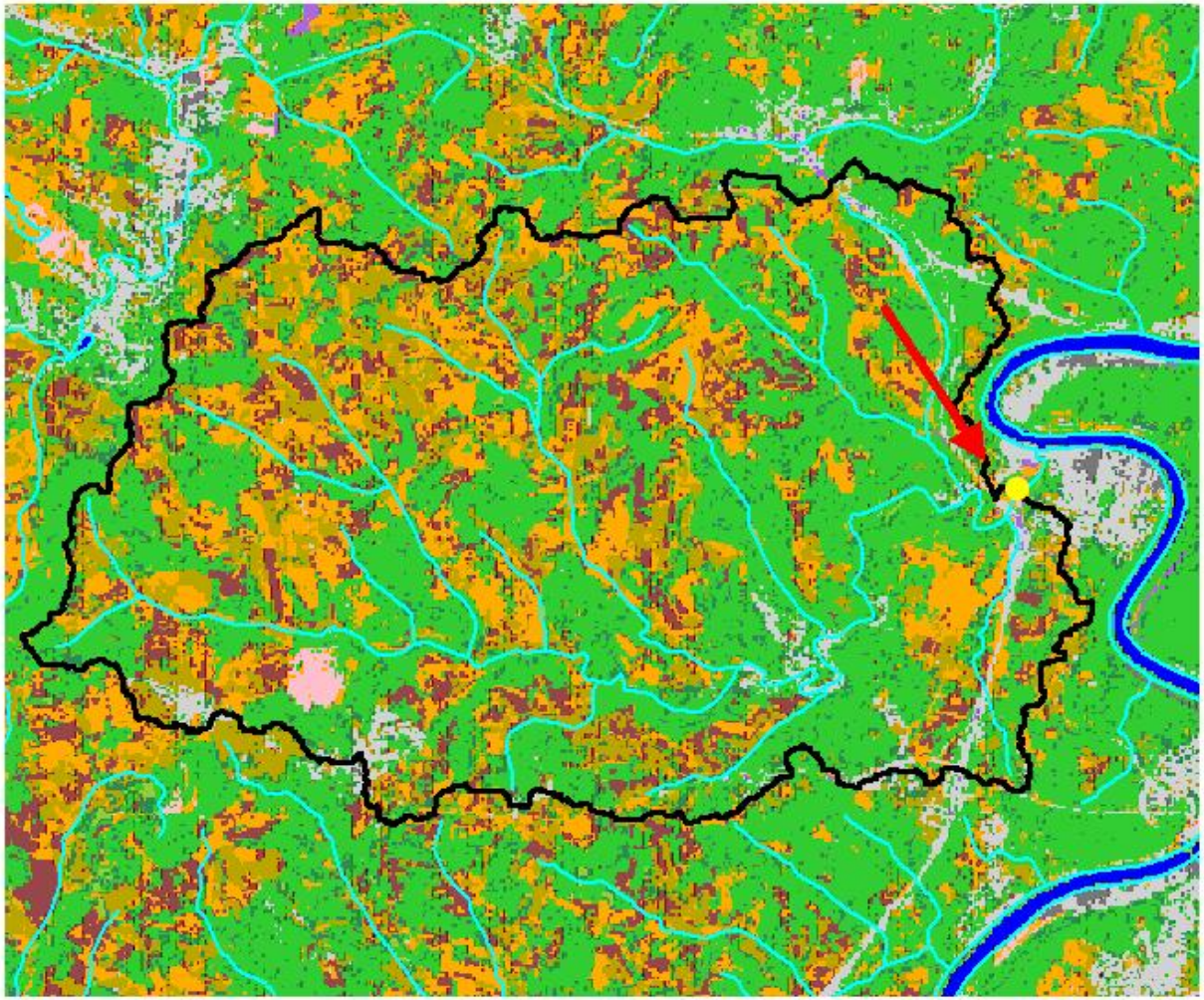


USGS Loading Sample Sites and Associated Watersheds

Location of Example Watershed



Example Watershed



EMAP 93 Sampling Point

Streams

Land Cover

- Water
- Low Intensity - Developed
- High Intensity - Developed
- Hay/Pasture/Grass
- Row Crops
- Probable Row Crops
- Conifer Forest
- Mixed Forest
- Deciduous Forest
- Woody Wetlands
- Emergent Wetlands
- Barren; Quarry
- Barren; Coal Mines
- Barren; Beach Areas
- Barren; Transitional

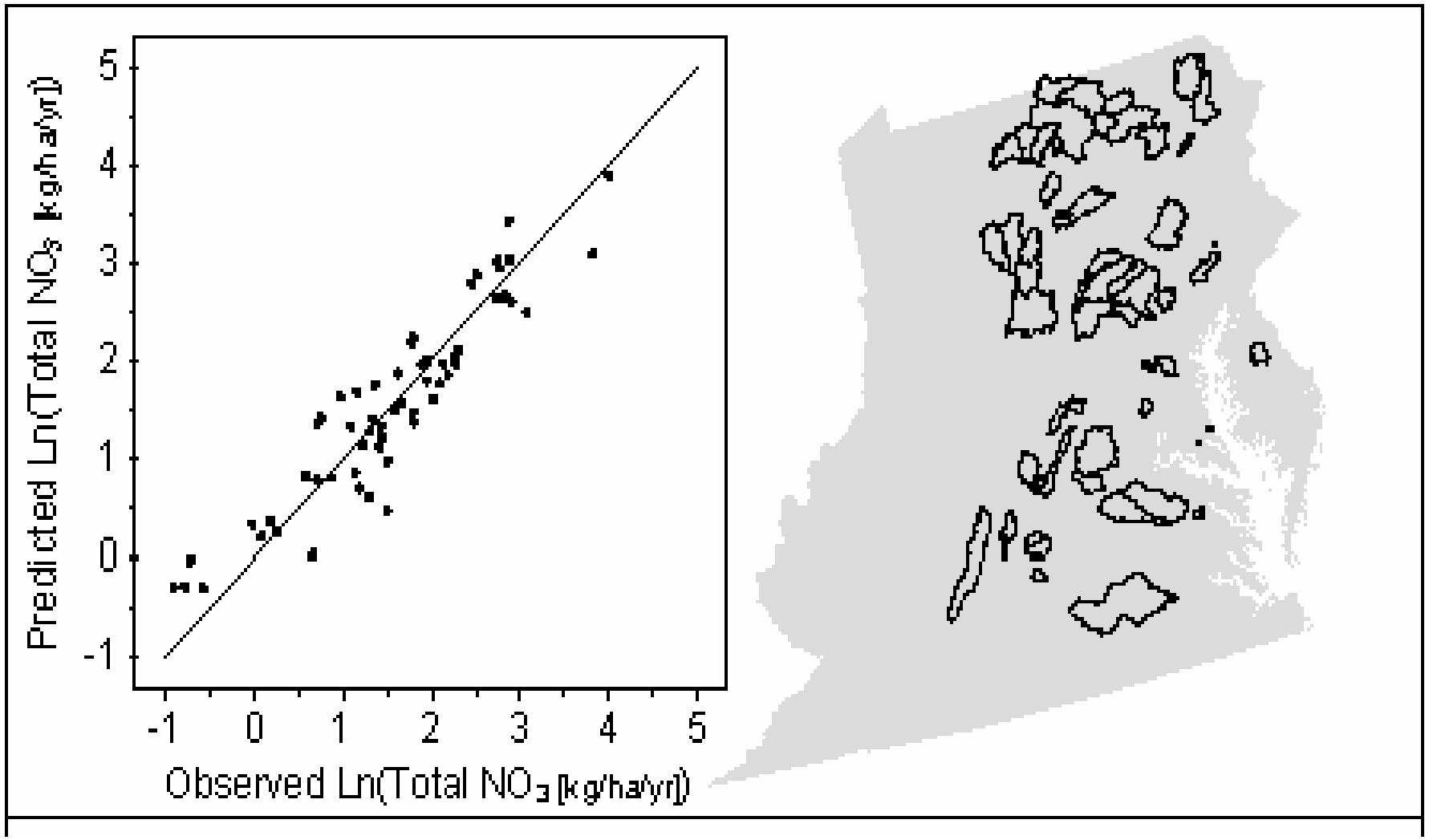
N

W E

S

3 0 3 6 Miles

Multiple Step-wise Regression

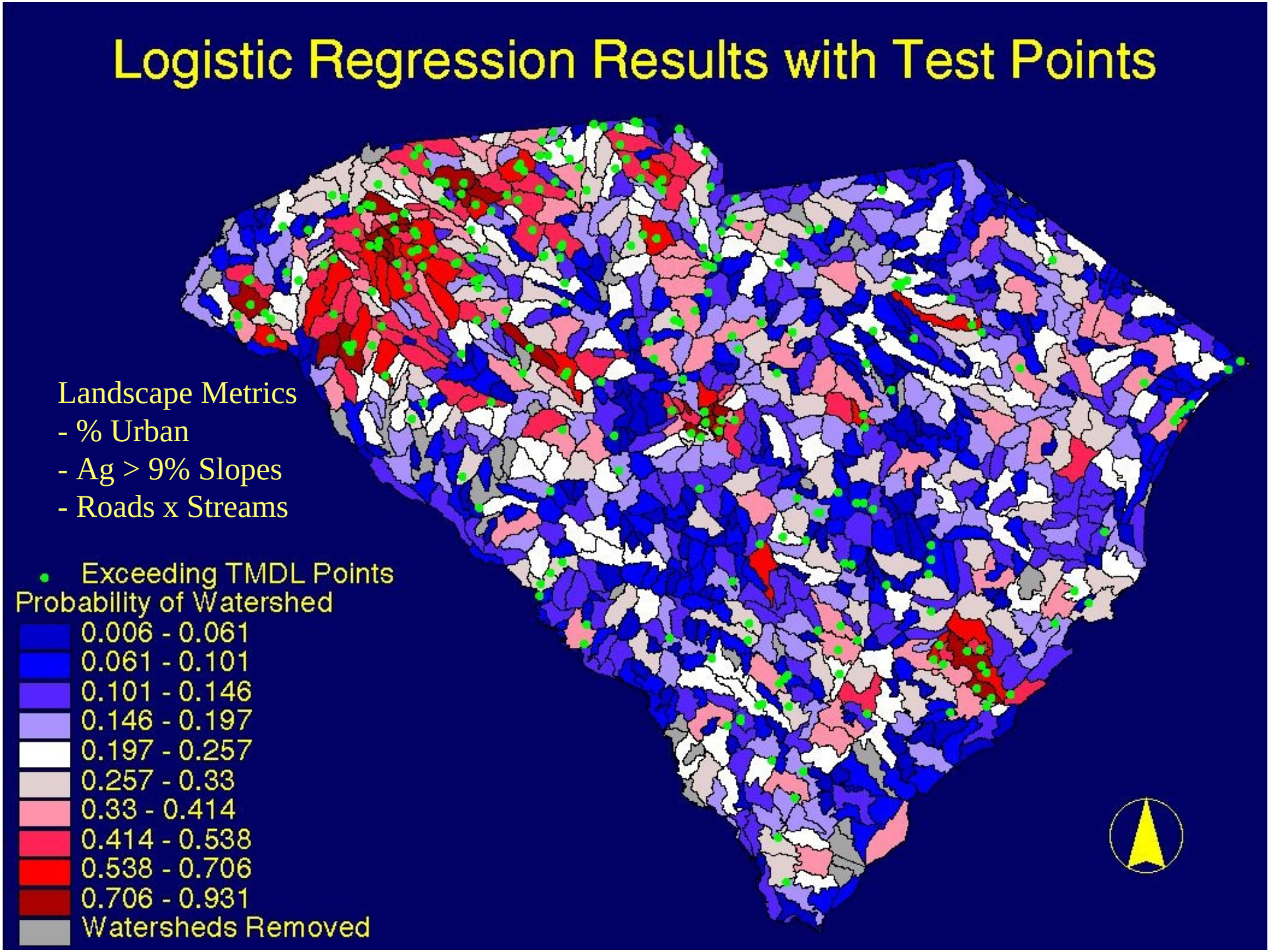


$R^2 = .86$ % Ag, Nitrate Deposition, Roads X Sreams, % Urban

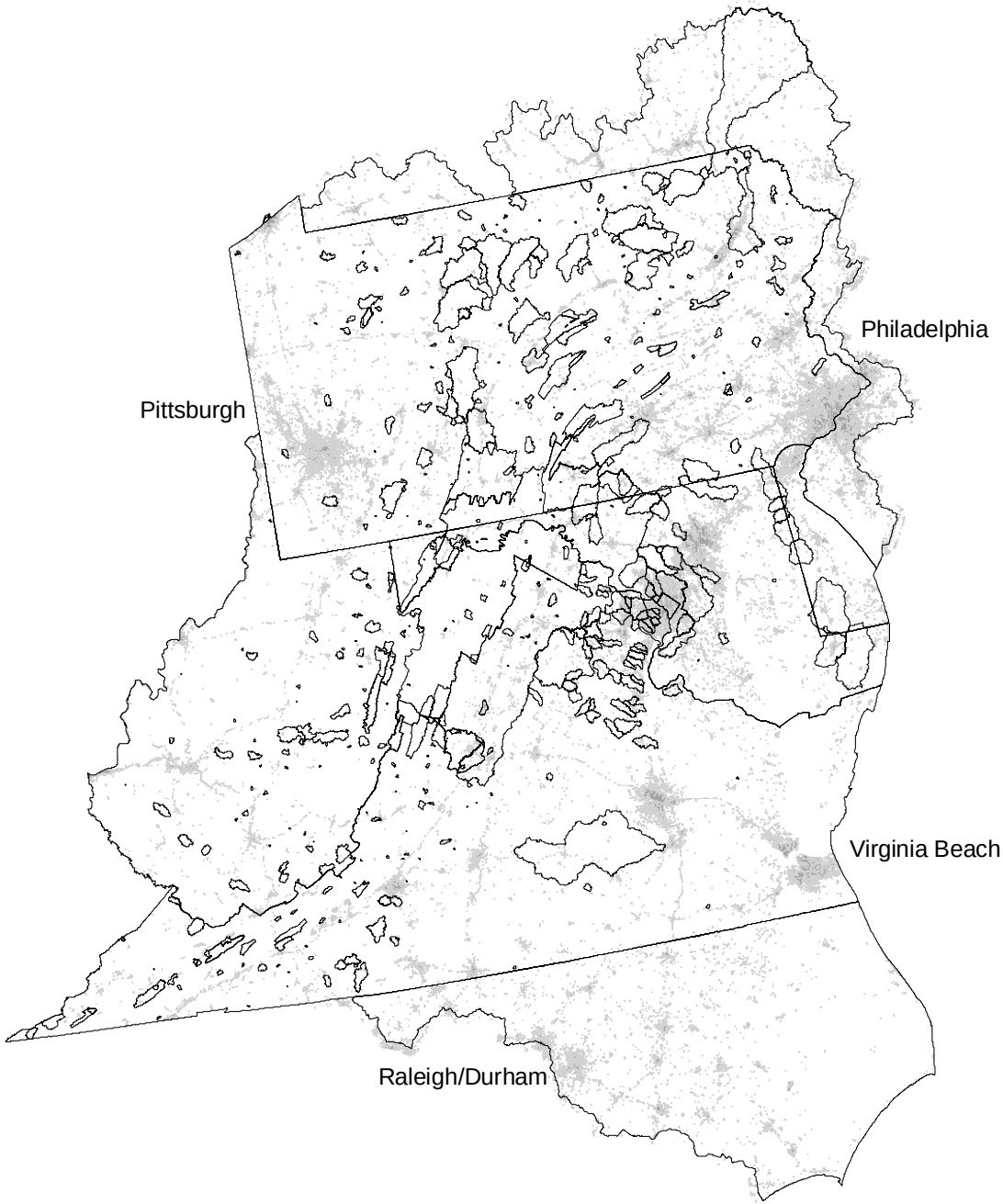
Logistics Regression

- Uses threshold values and provides cross-validation and probabilities of exceeding a threshold based on a set of independent variables (landscape and biophysical variables)

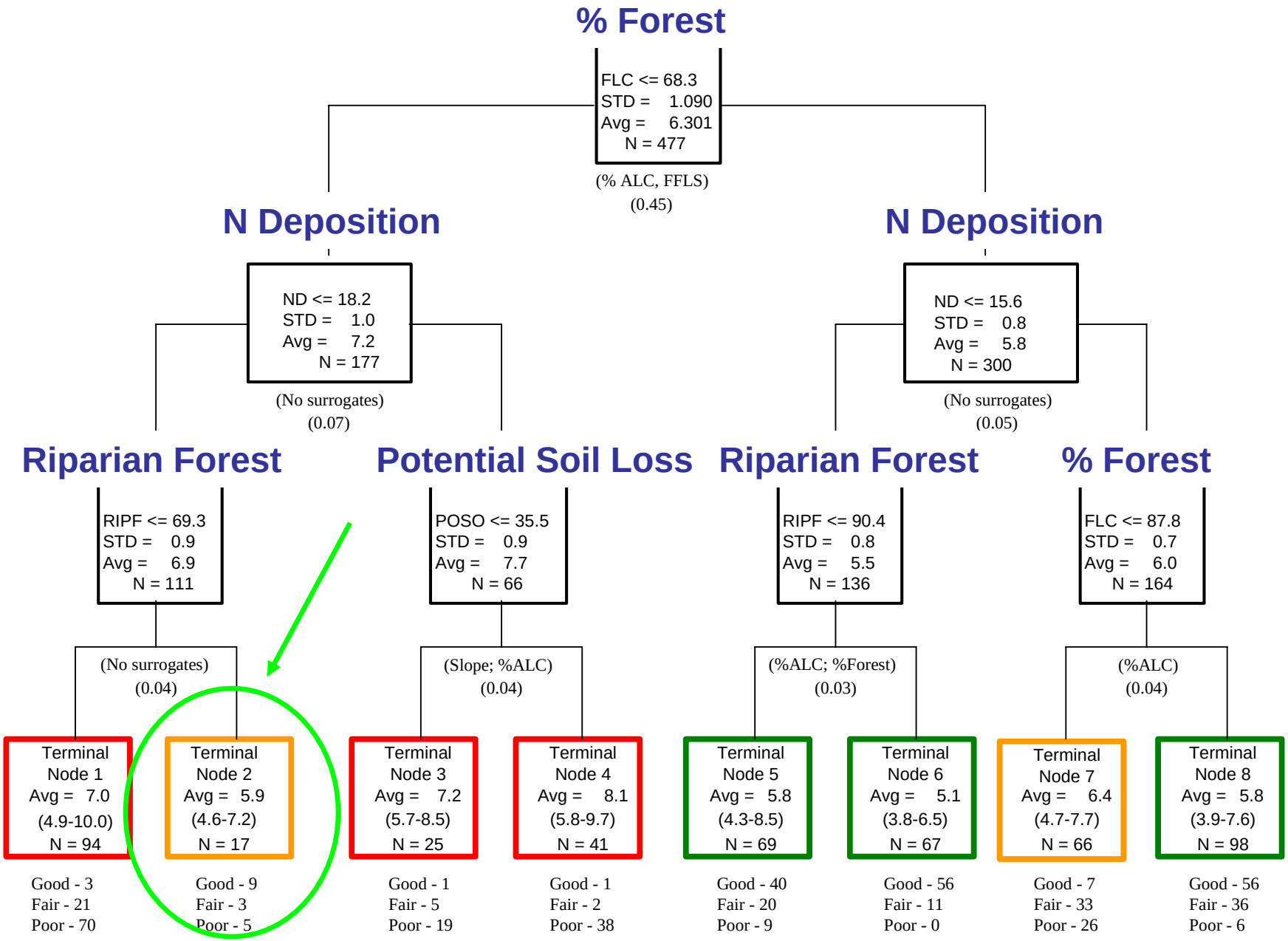
Logistic Regression Results with Test Points

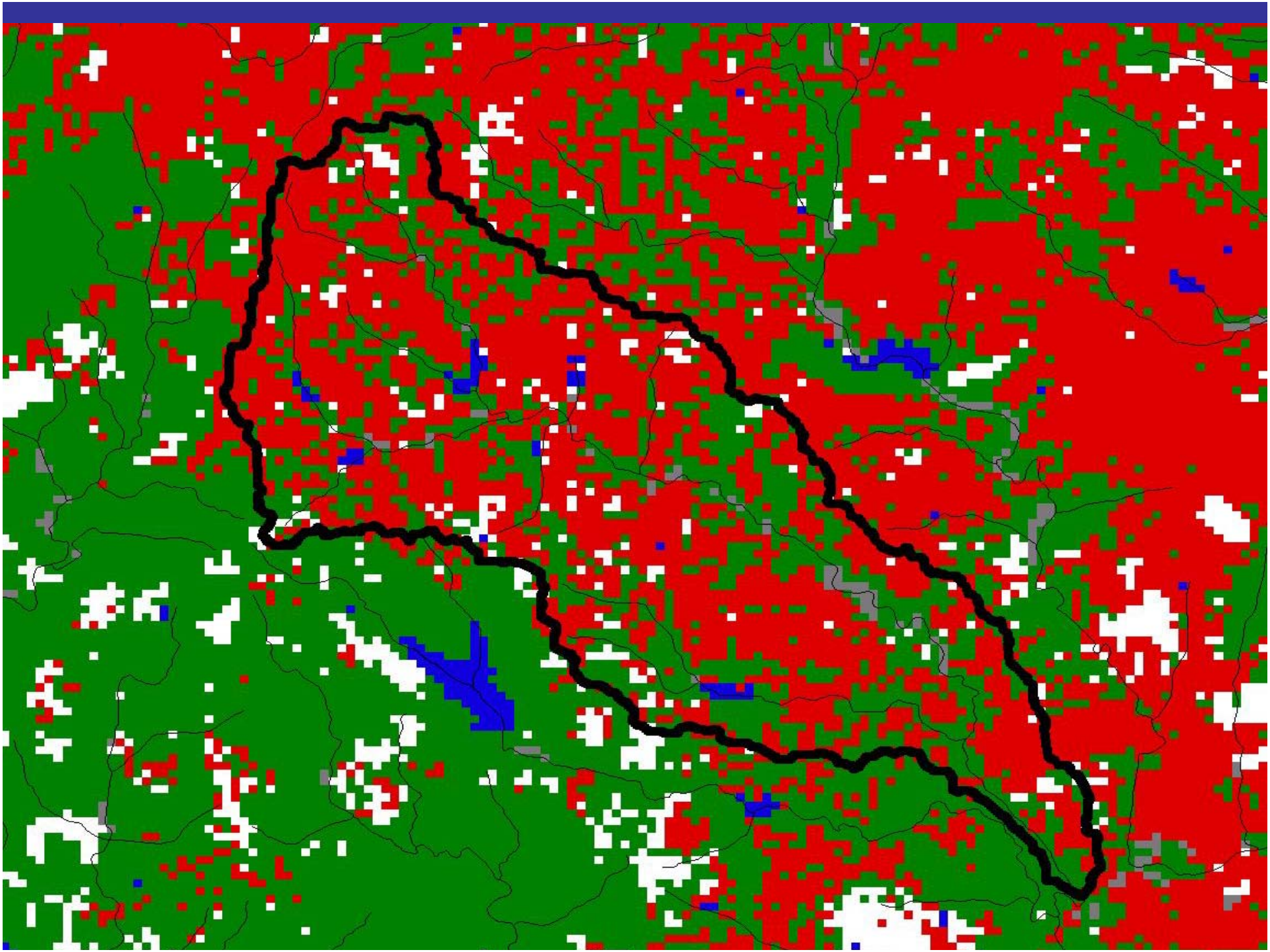


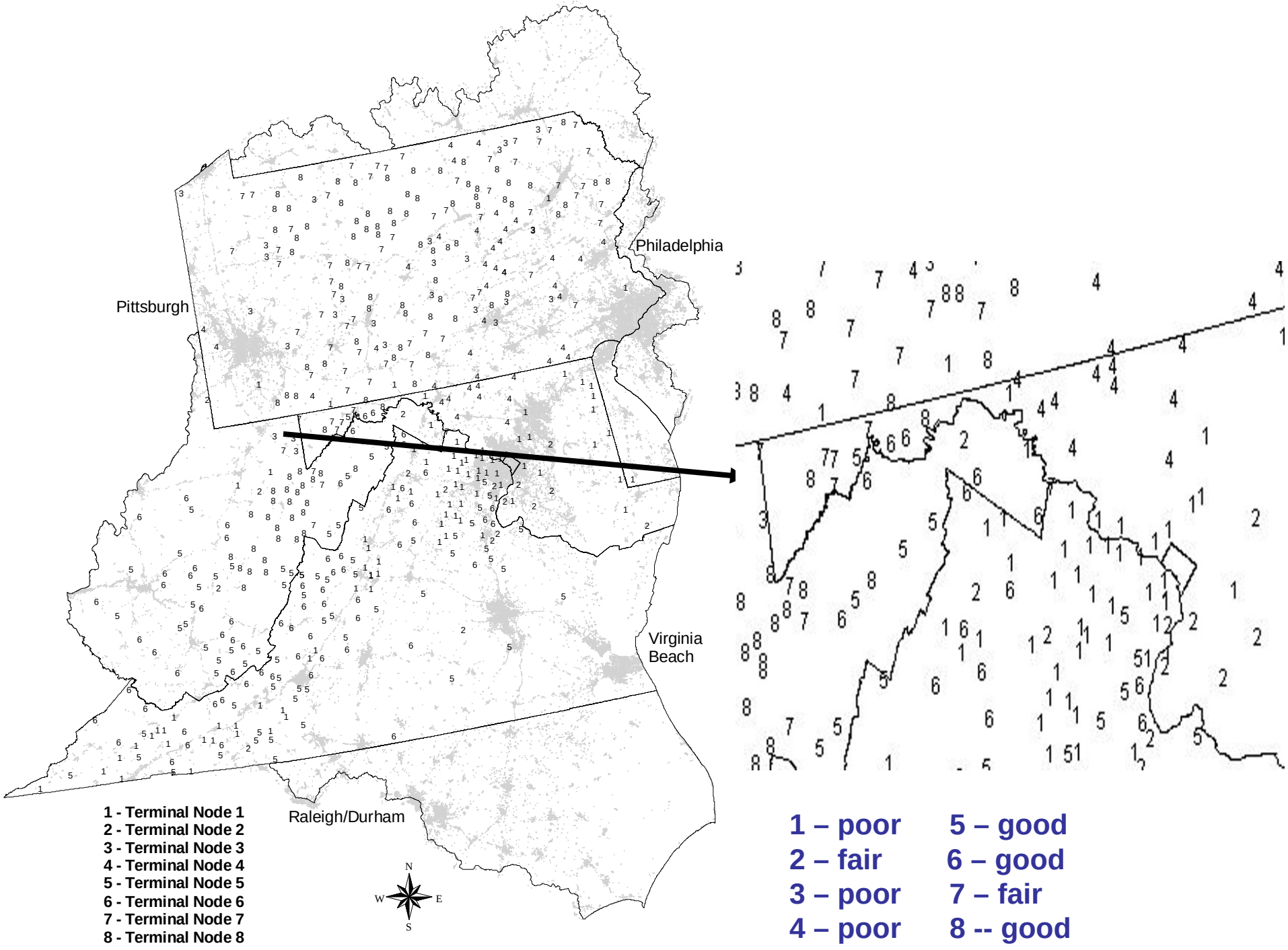
Classification and Regression Tree (CART) Analysis – An Inductive Approach


Philadelphia
Pittsburgh
Virginia Beach
Raleigh/Durham
Watershed boundaries
N
W
E

CART Analysis – N concentration in MAIA Streams





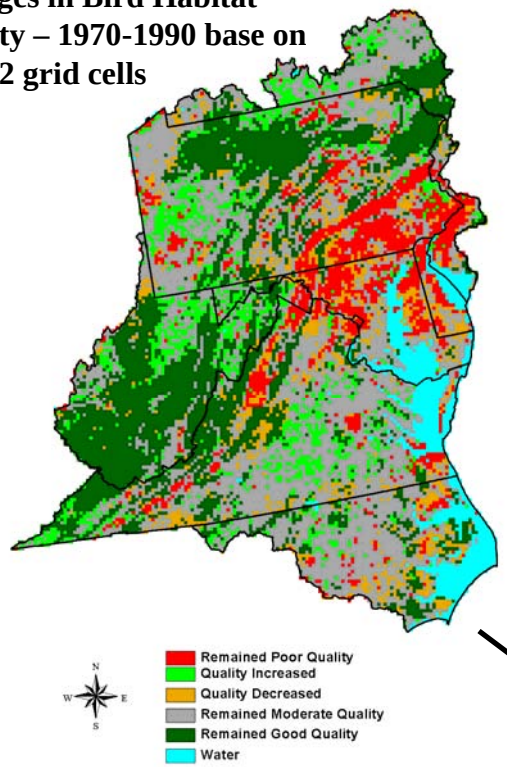


1 - Terminal Node 1
2 - Terminal Node 2
3 - Terminal Node 3
4 - Terminal Node 4
5 - Terminal Node 5
6 - Terminal Node 6
7 - Terminal Node 7
8 - Terminal Node 8

1 – poor
2 – fair
3 – poor
4 – poor
5 – good
6 – good
7 – fair
8 -- good

Integration of Multiple Environmental Endpoints through Landscape Analysis

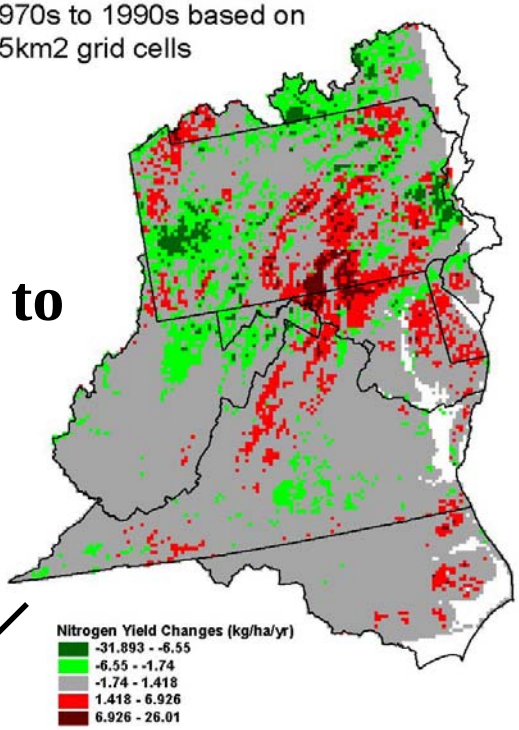
Changes in Bird Habitat Quality – 1970-1990 base on 25km2 grid cells

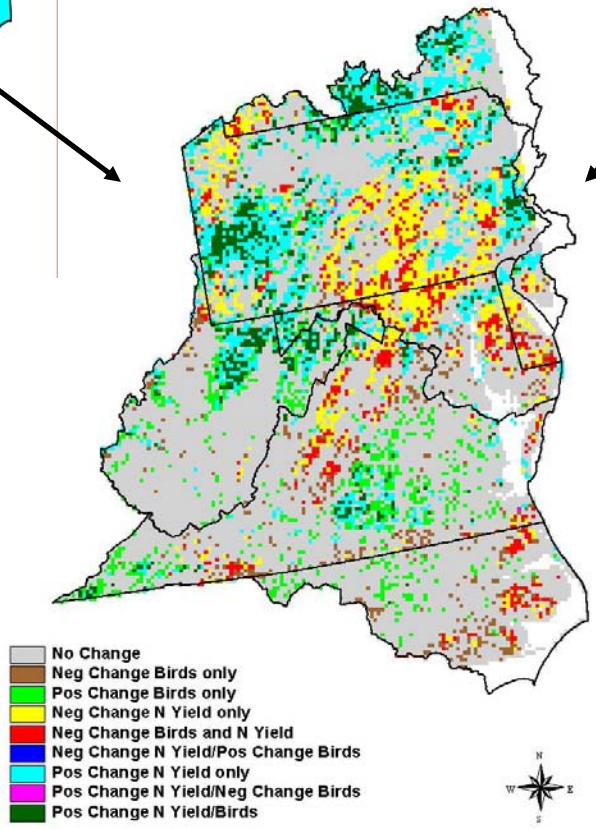


Bird Habitat Quality

Nitrogen Loadings to Streams

Nitrogen Yield Change for MAIA 1970s to 1990s based on 25km2 grid cells



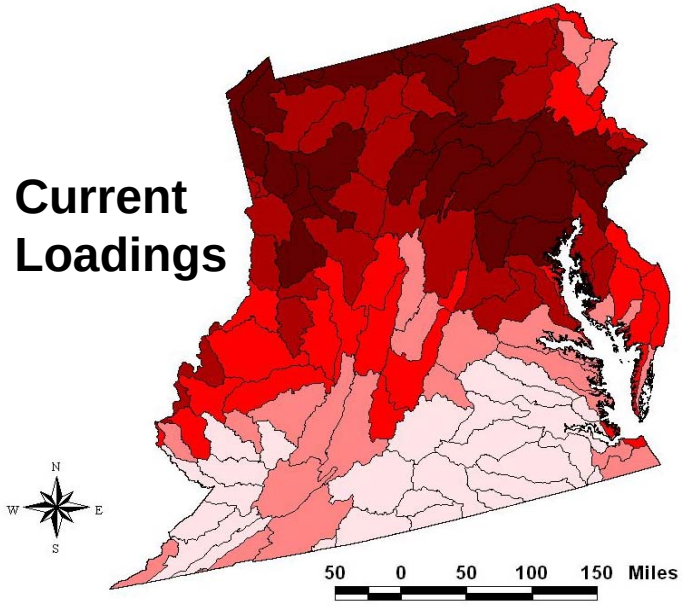


Forecasting and Alternative Futures Analysis

Evaluating Alternative Risk Management Options:

Linking Nutrient Loadings with Restoration Potential

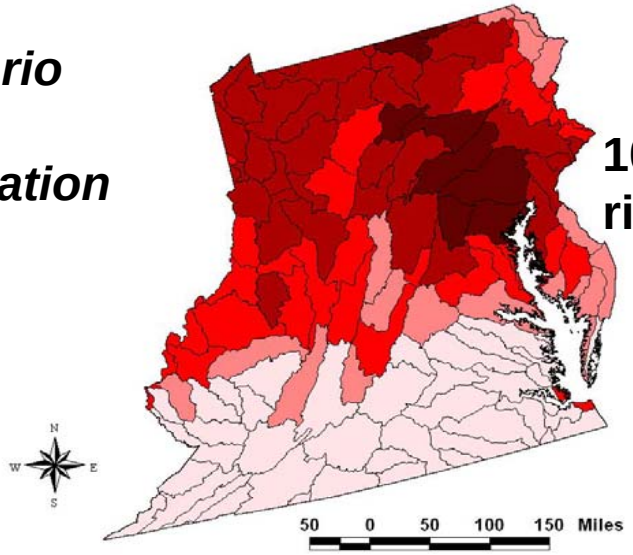
Current Loadings



Nitrogen loadings (lbs/acre/year) as predicted by current conditions

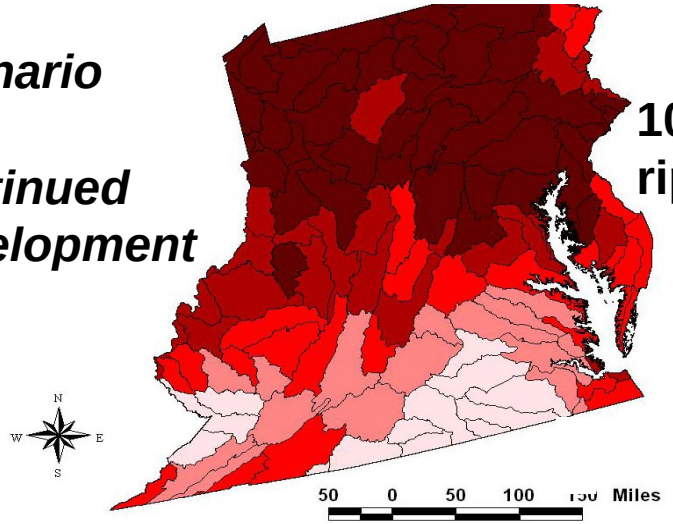
- 0.989 - 1.812
- 1.812 - 2.738
- 2.738 - 4.52
- 4.52 - 7.356
- 7.356 - 16.904

Scenario with restoration



10% increase in riparian forest

Scenario with continued development



10% decrease in riparian forest

Ongoing and Future Research

- Landscape indicators and models that capture horizontal interactions … to understand importance of position in the landscape and neighborhood influences
  - Linkage to hydrologic models that establish cell-to-cell flow networks
  - Distance metrics that weight individual cells and patches relative to their influence and contribution

- Web-based analysis tools


Questions?
THE
LITTLE
RASCALS
.NET